



The Role of Metadata in Simulation Based Acquisition Activities

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Topics



- Role of data in modeling and simulation
- Role of metadata in M&S data management
- Verification, validation, and accreditation of data
- Categories of metadata
- Lineage/pedigree metadata
- Metamodel for M&S data management
- Applying the metamodel



Joint Strike Fighter Vision

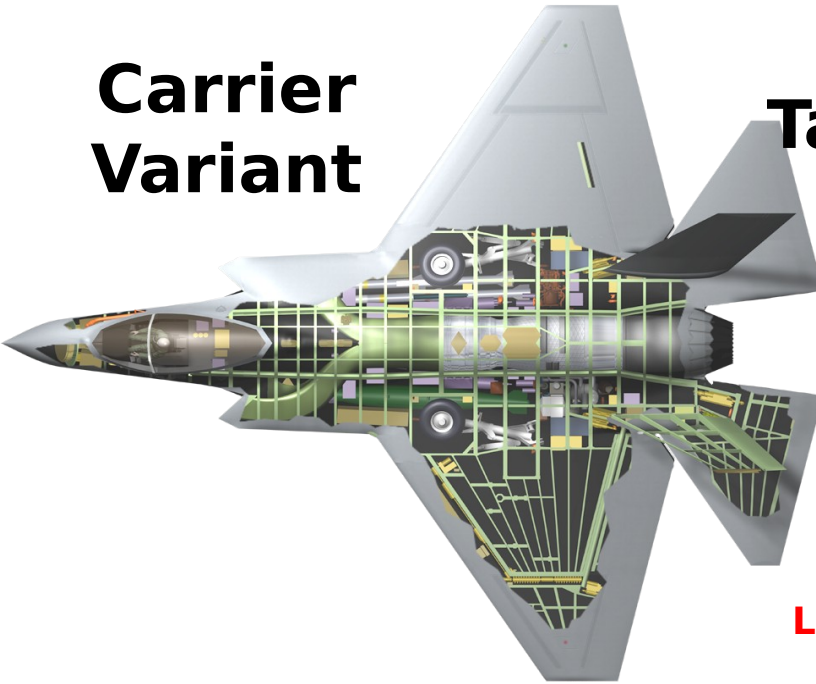
**BE THE MODEL ACQUISITION PROGRAM FOR
JOINT SERVICE AND INTERNATIONAL
COOPERATION**

DEVELOP AND PRODUCE AN **AFFORDABLE
NEXT GENERATION STRIKE FIGHTER WEAPON
SYSTEM AND SUSTAIN IT WORLDWIDE**



JSF Variants

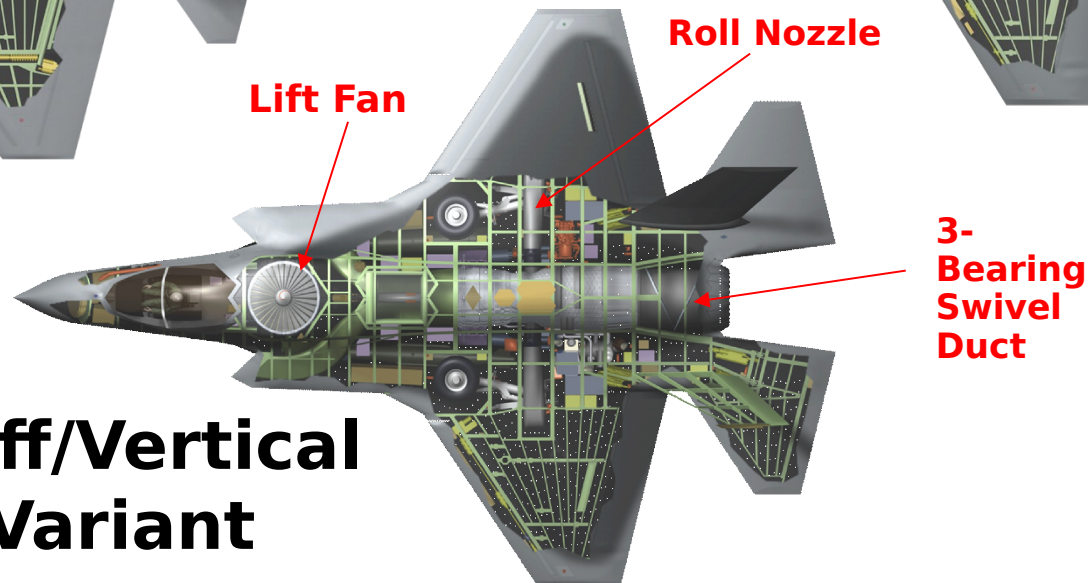
Carrier Variant



Conventional Takeoff and Landing Variant



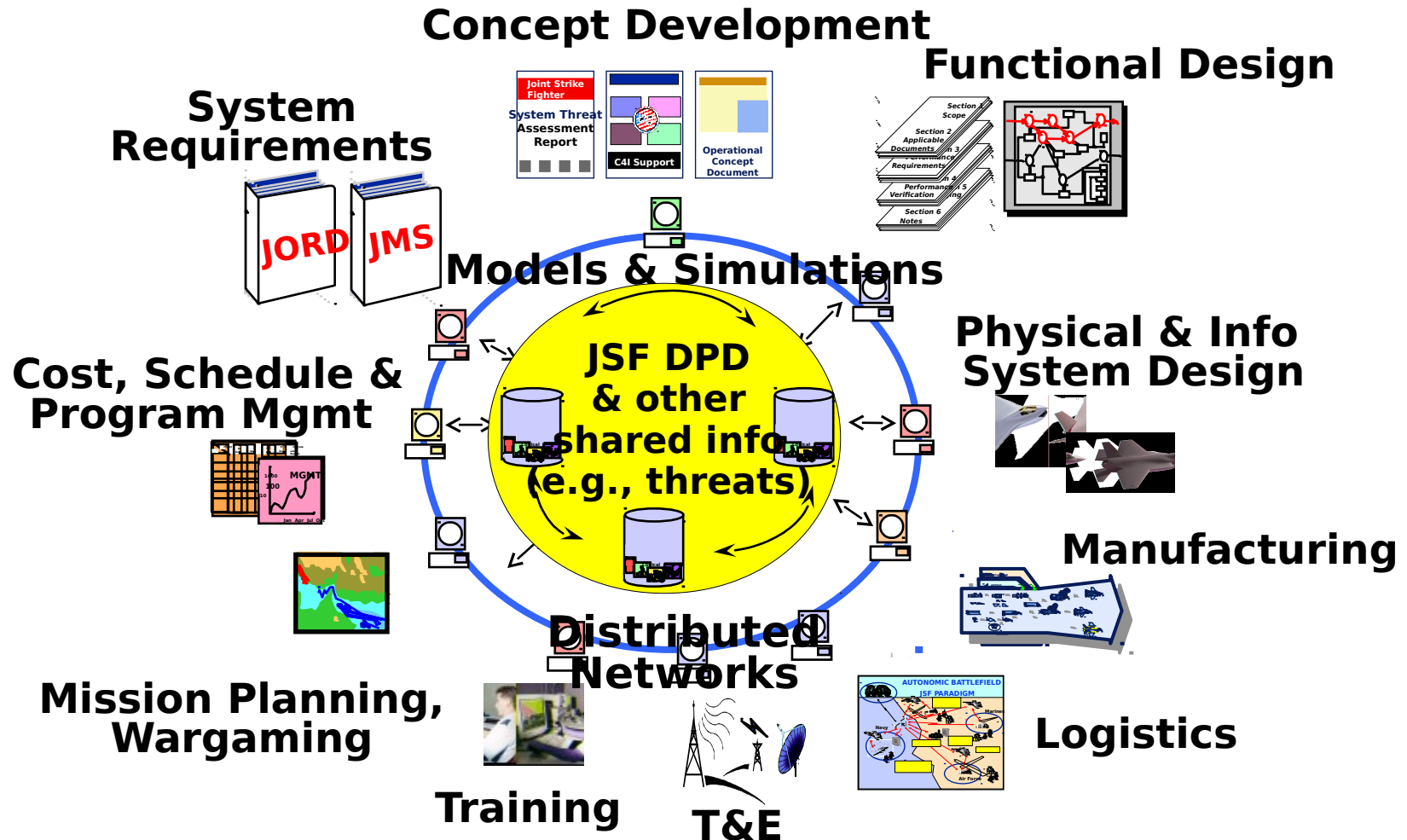
Short Takeoff/Vertical Landing Variant





Simulation Based Acquisition

(JSF M&S Support Plan Fig. 5-3)



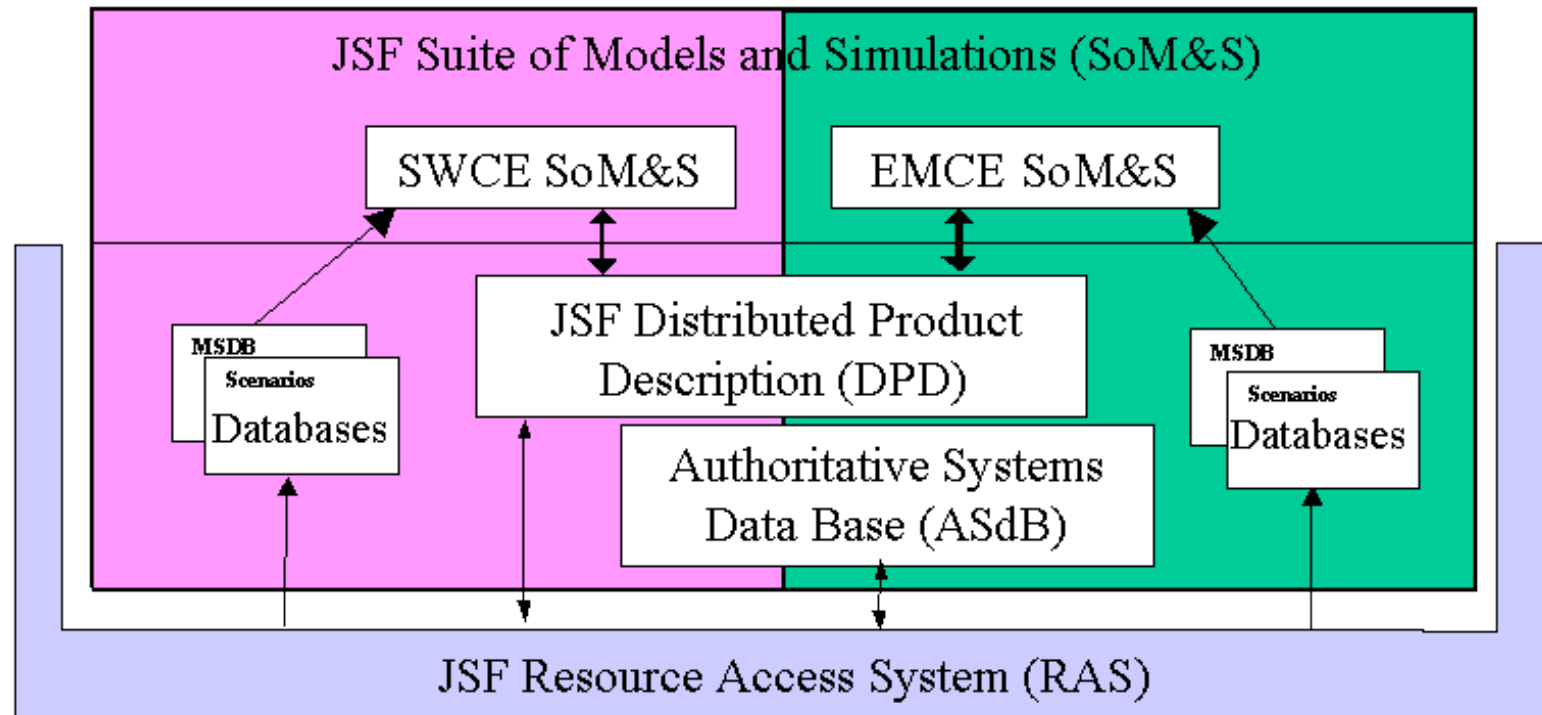


Components of the JSF M&S Toolset

(JSF M&S Support Plan Fig 3-1)

Strike Warfare
Collaborative Environment
(SWCE) Toolset

Engineering & Manufacturing
Collaborative Environment
(EMCE) Toolset





JSF Authoritative Modeling Information System (JAMIS) Concept



Register proposed designs (LMAero)

Resource Access System (RAS)

JSF [DPD]

Interactions (P_d , P_k , etc.)

Threat & friendly systems [ASDB]

Natural environment, infrastructure

Operational context

Study-specific archives

User interface admin data

Linking & translation services (mapping semantics/syntax)

Digital System Models

Blue system C&P info

Threat C&P information

Natural environment & infrastructure C&P info

Operational context info

Register authoritative data (JSFPO)

Register DT & OT test results

Register design decision

JSF design change decisions

JSF control boards

Register smoothed / analyzed results

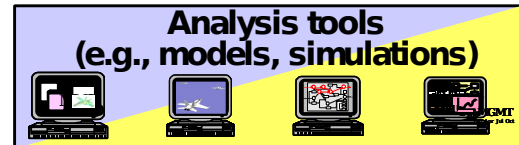
Relevant info / DSMs in tool-specific form

Design change MoMs

Analyst action

Study-specific input datasets & software code

Raw M&S results



Color key:

- JSFPO provided
- LMAero provided

Program Offices

Intel Centers

NIMA, DTRA, NRO, etc.

Services, JFCOM, etc.

LMAero Team, Operational Test Authorities

NDIA Systems Engineering



Data Engineering for Simulation Based Acquisition

- Modeling and simulation is the cornerstone of the complete product lifecycle in SBA. Data is the fuel that drives M&S and the product of M&S.
- The Distributed Product Description alone is not enough. Data engineering for an SBA project must address:
 - Information about the system under development (DPD)
 - Information about the systems with which it will interact
 - Information about the environment in which these systems will operate
 - Information about the operational context in which analyses are performed (scenarios, use cases, firing doctrine, ...)
- Data coherency must be maintained
 - Temporal coherence - data being used for different tools and sites represents the same point in the lifecycle development timeline
 - Organizational coherence - organizations across the enterprise are using the same set of databases
 - Layer (tier, level, stratum) coherence - information at a given level of abstraction (e.g., engagement level) is logically consistent
 - Granularity coherence - information at different levels of abstraction is logically consistent



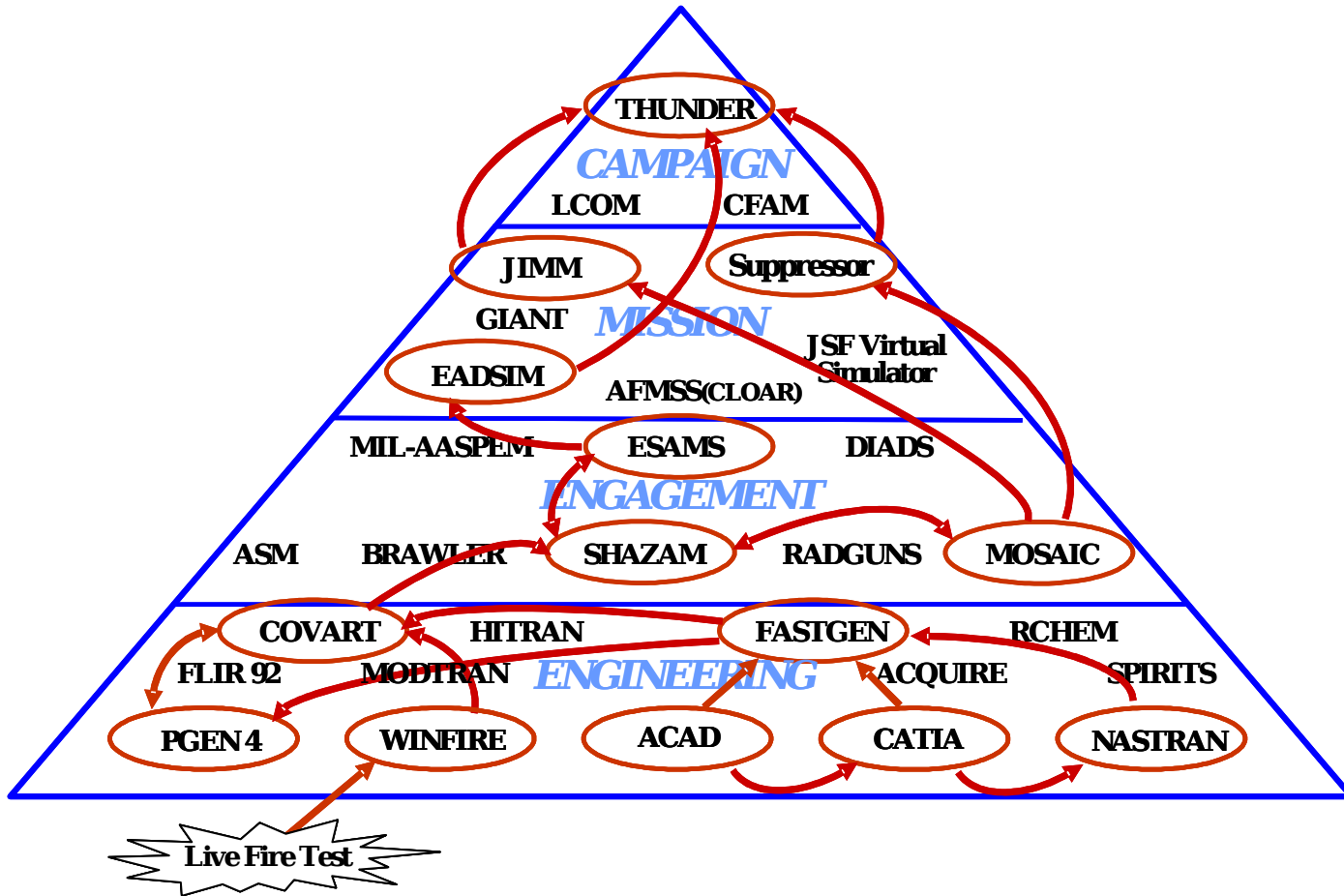
Goals for JSF M&S Metadata



- Provide a navigation path to allow users to locate data used by, produced by, and related to M&S activities.
- Provide descriptions of data sufficient for the user to understand what they are accessing.
- Provide pedigree metadata that tracks
 - the lineage of data
 - any assessments of quality
 - the appropriate uses of the data.



Example of JSF Data Lineage





M&S Verification, Validation, and Accreditation (VV&A)

From DoD Instruction 5000.61 (DoD M&S VV&A)

- **Verification** - The process of determining that a model implementation and its associated data accurately represents the developer's conceptual description and specifications.
- **Validation** - The process of determining the degree to which a model and its associated data are an accurate representation of the real-world from the perspective of the intended uses of the model.
- **Accreditation** - The official certification that a model, simulation, or federation of models and simulations and its associated data are acceptable for use for a specific purpose.



Metadata Types



- Structure metadata
 - Metadata applicable to all instances of a type of data (e.g., data element definitions, datatypes, entity relationships, data element relationships, etc.)
 - Example: ISO 11179
- Pedigree metadata (aka instance metadata)
 - Data set/data value metadata
 - Example: Dublin Core
 - Metadata about the instance data in the JAMIS regarding source, use, lineage, and VV&A



JAMIS Metadata Products



- JAMIS Metamodel
 - Relational metamodel represented in IDEF1X
 - Data dictionary
 - Tabular representation in Excel
 - XML Schema
 - GUI Implementation
- JAMIS Information Model – defines the navigation path relationships for all RAS data
- ASDB Information Model – defines the detailed relationship in the ASDB
 - also defined in IDEF1X



Sources for the JAMIS Metamodel



- The Dublin Core Metadata Element Set
- Department of Defense Discovery Metadata Standard
- DoD VV&A Recommended Practices Guide
- The combined experience of the JSF Modeling Information Sources Action Team
 - JSF PO and supporting organizations
 - LM Aero
 - Paradigm Technologies, Inc.



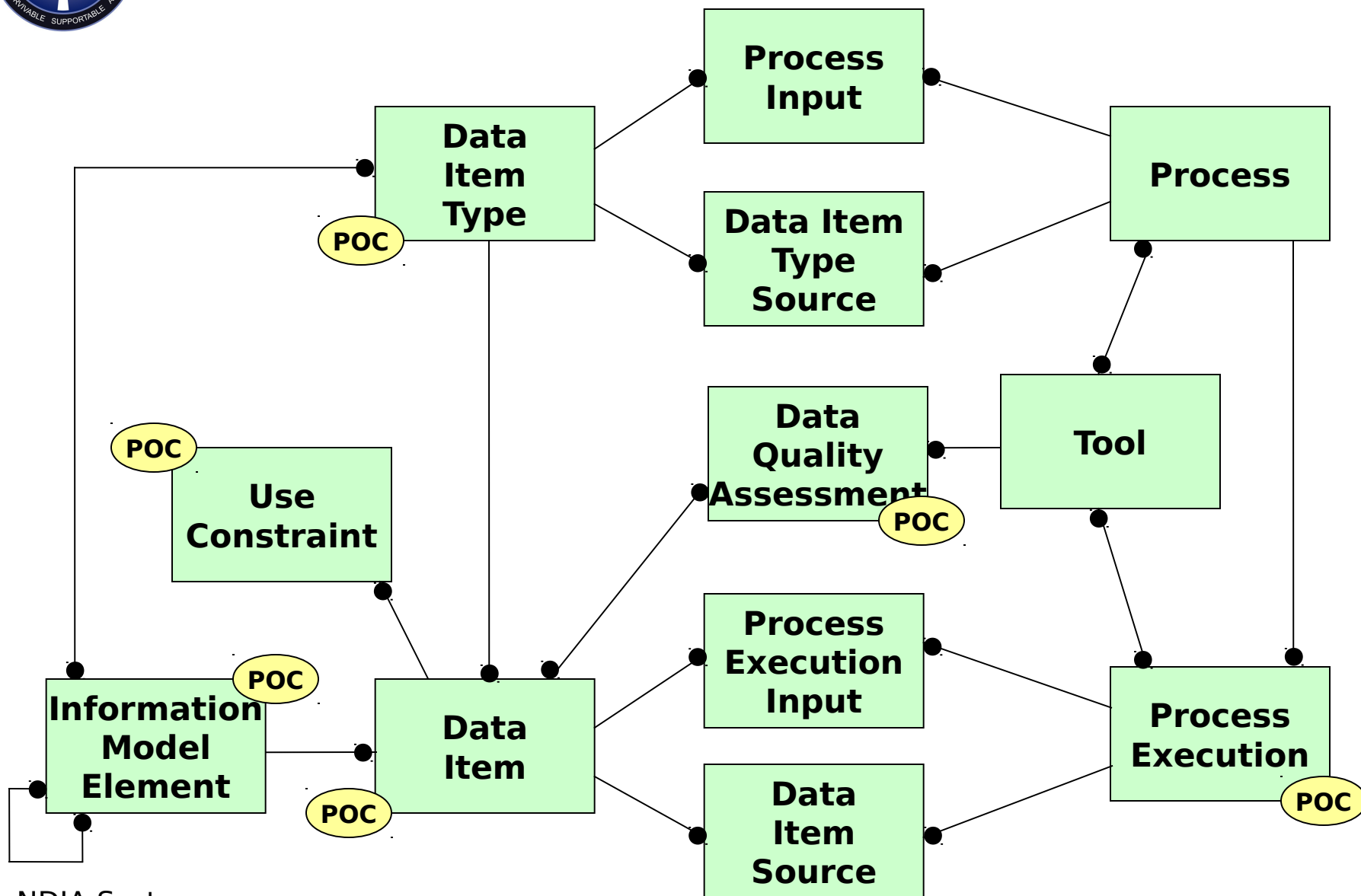
Major Metadata Concepts



- Information Model – A set of nodes in an information tree(s) and their relationships that 1) define information composition and 2) allow users to locate data.
- Information Model Element – A single node in the Information Model.
- Data Item Type – A type of data that can be associated with one or more information model elements (e.g. Brawler dataset).
- Data Item – An individual instance of a data item type, associated with some node of the information model.
- JAMIS Metamodel – The specification of the metadata that formalizes the concepts above and their relationships.

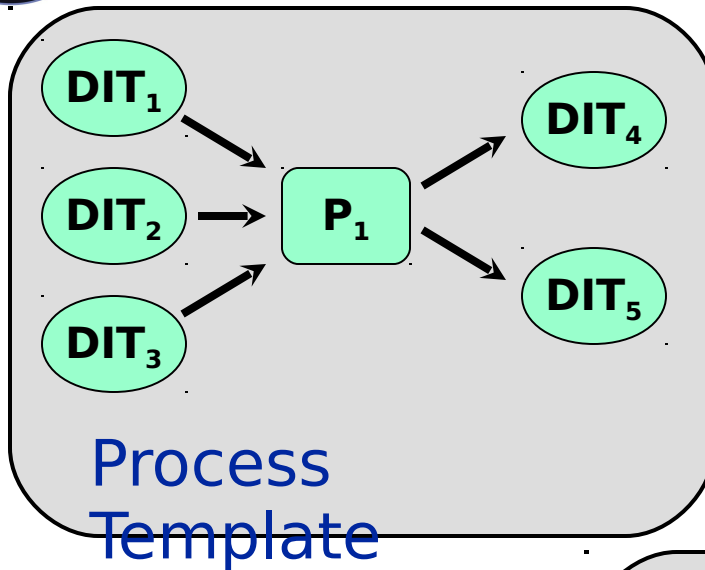


JAMIS Metamodel

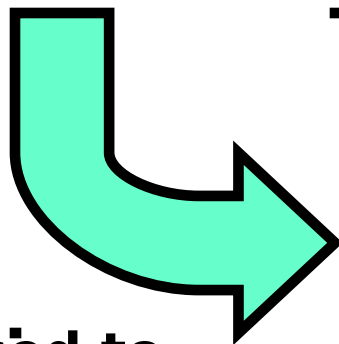




Use of Process Definitions

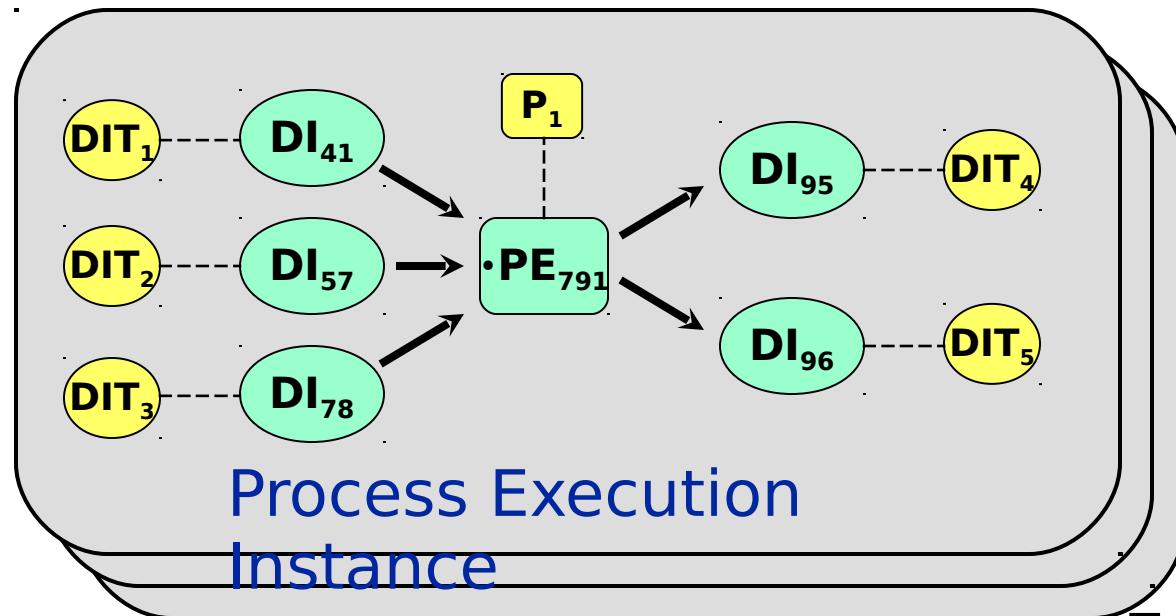


DIT - Data Item Type
DI - Data Item
P - Process
PE - Process Execution



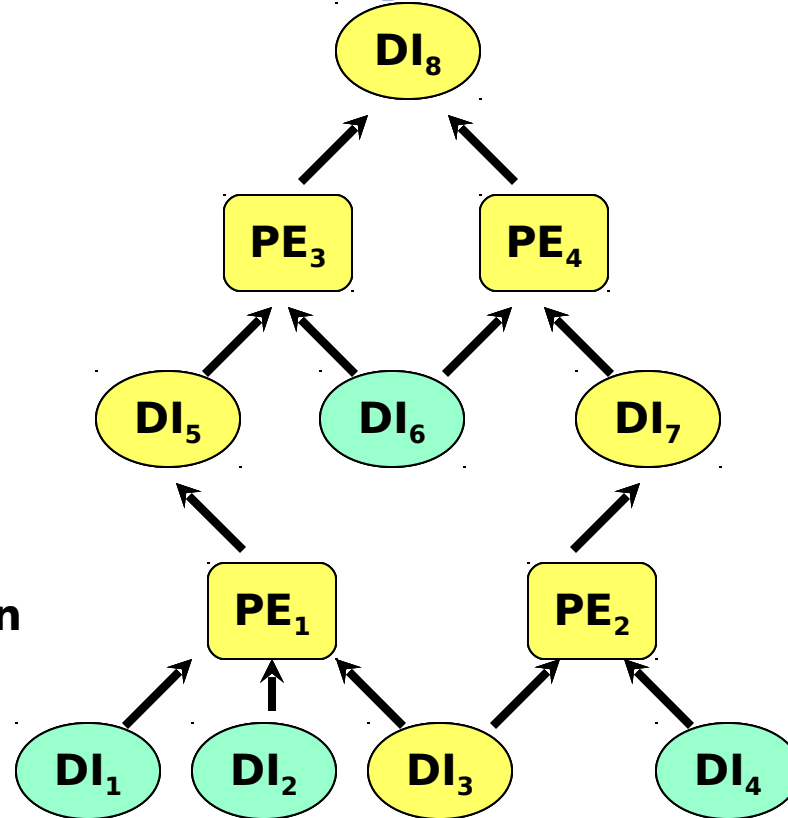
used to

- pre-populate
- validate





Impact Analysis and Consistency



DI - Data Item
PE - Process Execution

Impact Analysis: A change in DI1 potentially necessitates the re-execution of PE1 and PE3 to produce DI5 and DI8.

Consistency: A consistent version of DI3 must be used to eventually produce a coherent version of DI8.



Implementing the Metamodel for Product Data

- LM Aero will use a variety of product data management (PDM) systems to manage JSF data
 - Metaphase
 - LiveLink
 - Merant PVCS
- The RAS will provide the common access to data in the PDM systems
- Options for managing metadata
 - Manage metadata in the individual PDM systems
 - Manage metadata in the RAS
 - Split the responsibility between the PDM systems and the RAS



Implementing the Metamodel for Threat and Friendly System Data

- PTI uses Oracle databases for the implementation of the Authoritative Systems Database
- A linking model allows metadata to be associated with the appropriate “slice” of a relational database. Thus a data item can be
 - an entire database
 - a table or set of tables
 - a subset of the rows and/or columns
 - Individual data values (row-column intersections)
- Thus, metadata is not unnecessarily duplicated



Conclusions



- Metadata is critical to managing M&S data
- In addition to traditional structure metadata, pedigree metadata is needed to understand the lineage, quality, and use of data
- The JAMIS metamodel provides a reasonable approach to capturing the necessary metadata
- The JAMIS metamodel is currently being implemented in the management of JSF M&S data
- For a related paper, see